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Tang et al.

[54] **PRESTRESSED COMPRESSOR MOUNT INSTALLATION METHODS**

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[21] Appl. No.: **09/076,323**

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Related U.S. Application Data

[63] Continuation-in-part of application No. 08/881,673, Jun. 24, 1992, Pat. No. 5,964,579.

[51] **Int. Cl.**[7] **B23P 11/02**

[52] **U.S. Cl.** **29/450**; 29/235; 81/300

[58] **Field of Search** 29/450, 235; 81/300

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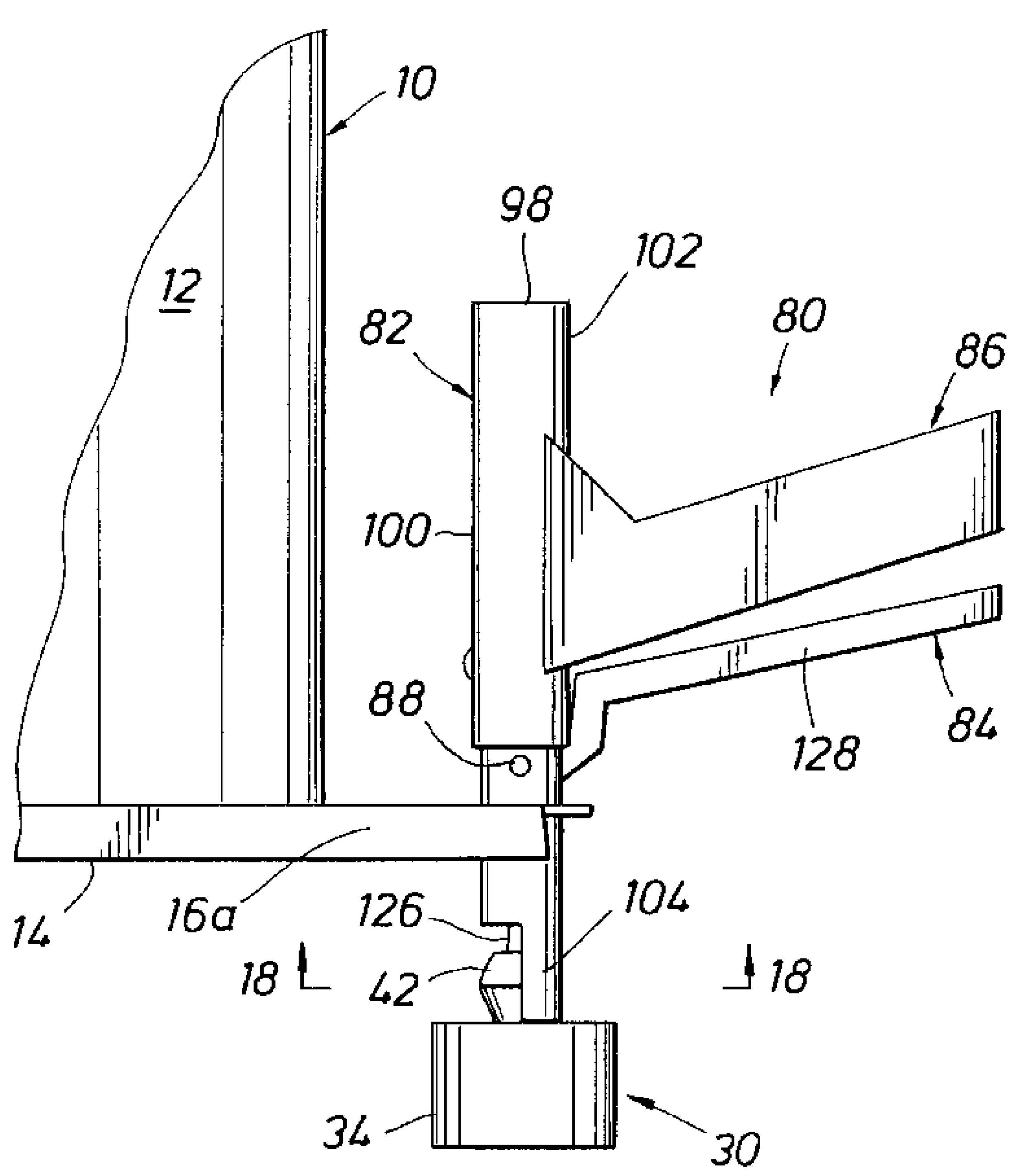
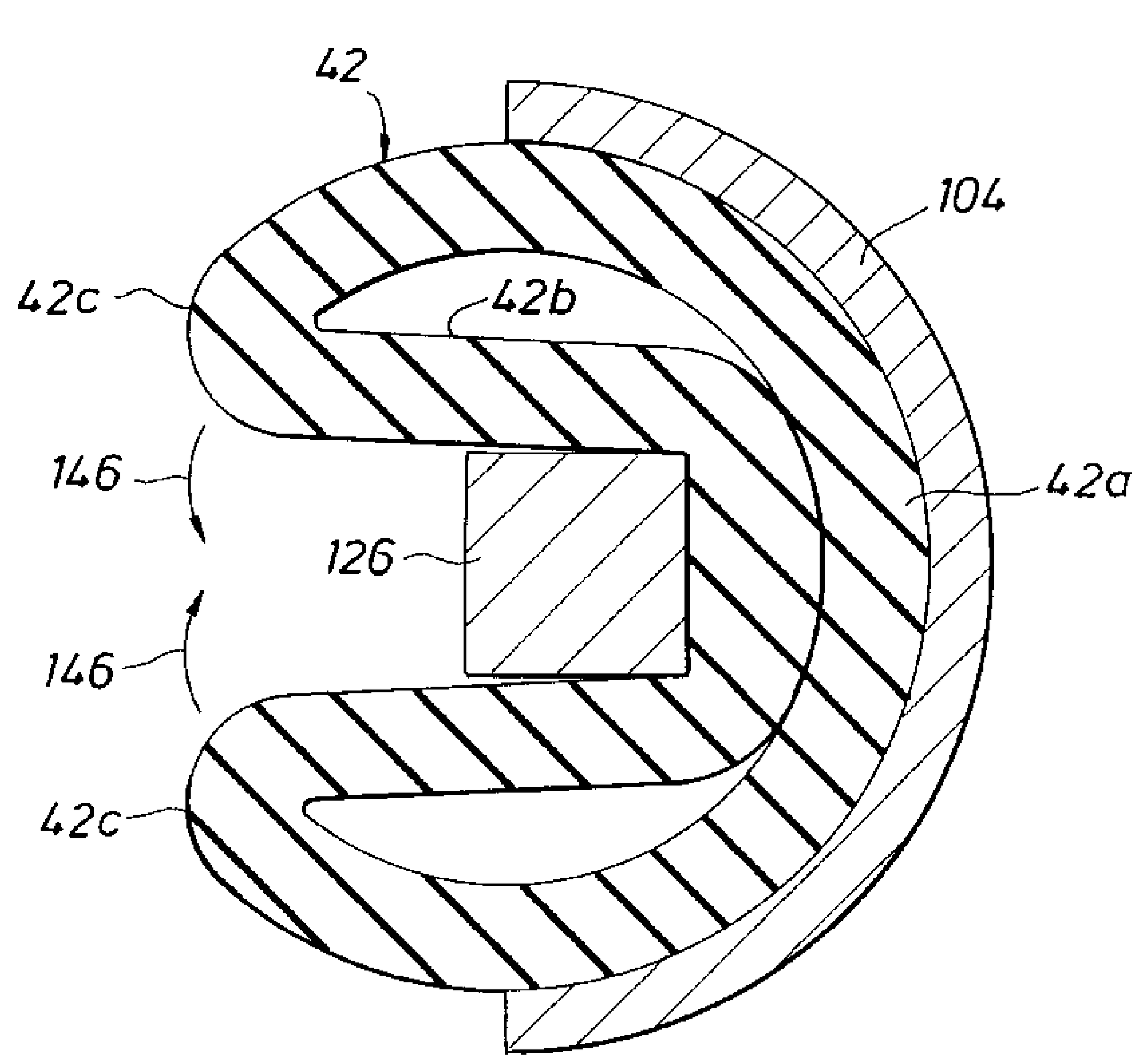
Assistant Examiner—John C. Hong
Attorney, Agent, or Firm—Konneker & Smith, P.C.

[57] **ABSTRACT**

An elastomeric compressor mount has a hollow convex cylindrical head portion which must be passed upwardly through a substantially smaller diameter circular opening in a support foot portion of the compressor. To facilitate the passage of the mount head portion through the support foot opening a specially designed clamping tool is provided which has an arcuate support portion and a clamping portion that may be pivoted toward and away from a concave side surface of the support portion. With these two tool portions pivoted toward each other they are inserted downwardly through the compressor foot opening, opened, and then clamped exteriorly onto the mount head portion in a manner deforming it to a generally U-shaped configuration as viewed along the axis of the mount. The deformed mount head portion, and the still clamped together tool portions are then pulled upwardly through the compressor foot opening, the free ends of the deformed, generally U-shaped mount head portion being pushed toward one another by side edge portions of the foot opening as the head portion passes upwardly through the opening. After the deformed mount head portion is positioned above the top side of the compressor foot, the tool is released to permit the mount head portion to spring back to its original annular configuration and overlie an annular top side surface portion of the compressor foot.

9 Claims, 7 Drawing Sheets





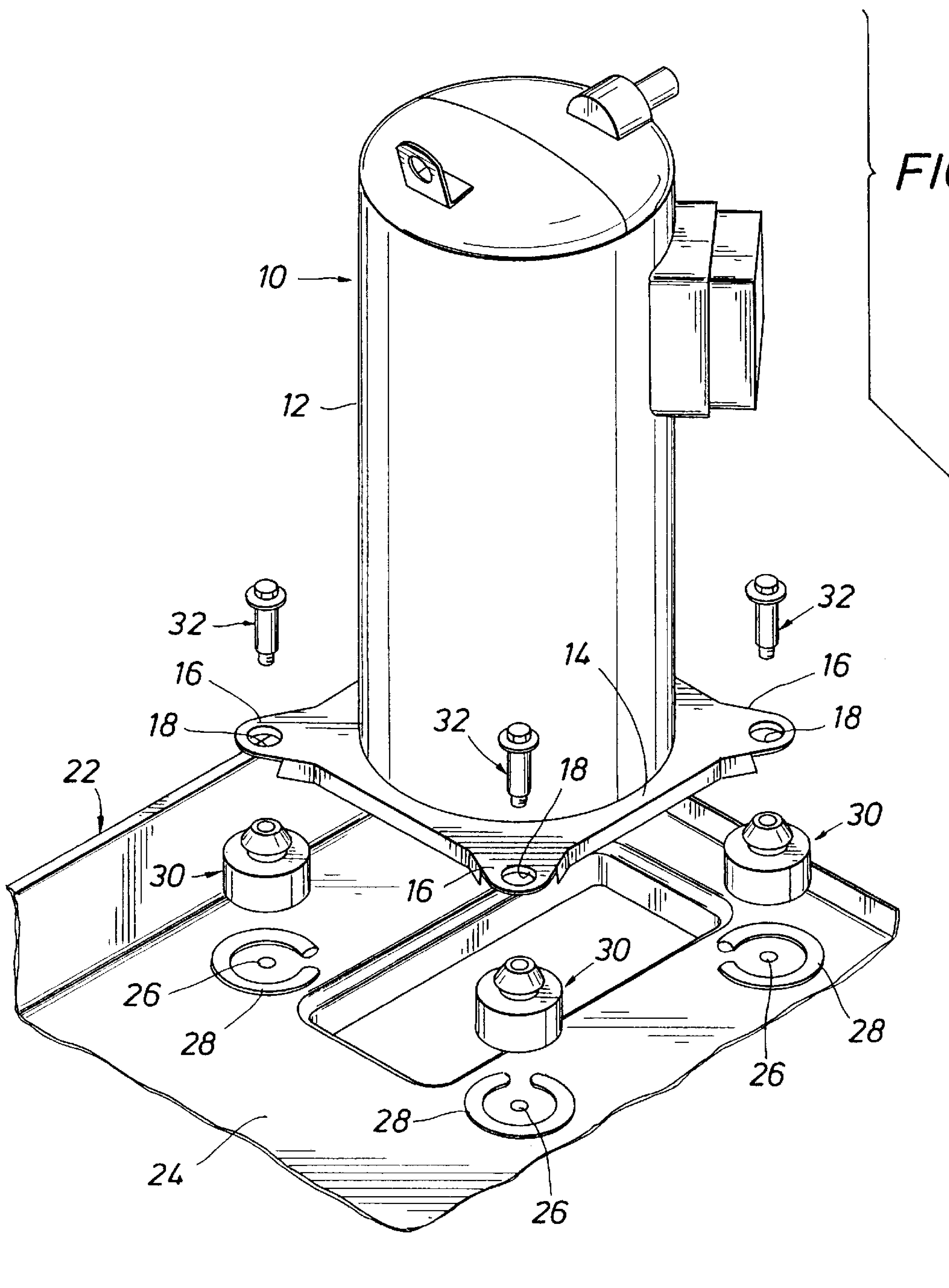


FIG. 1

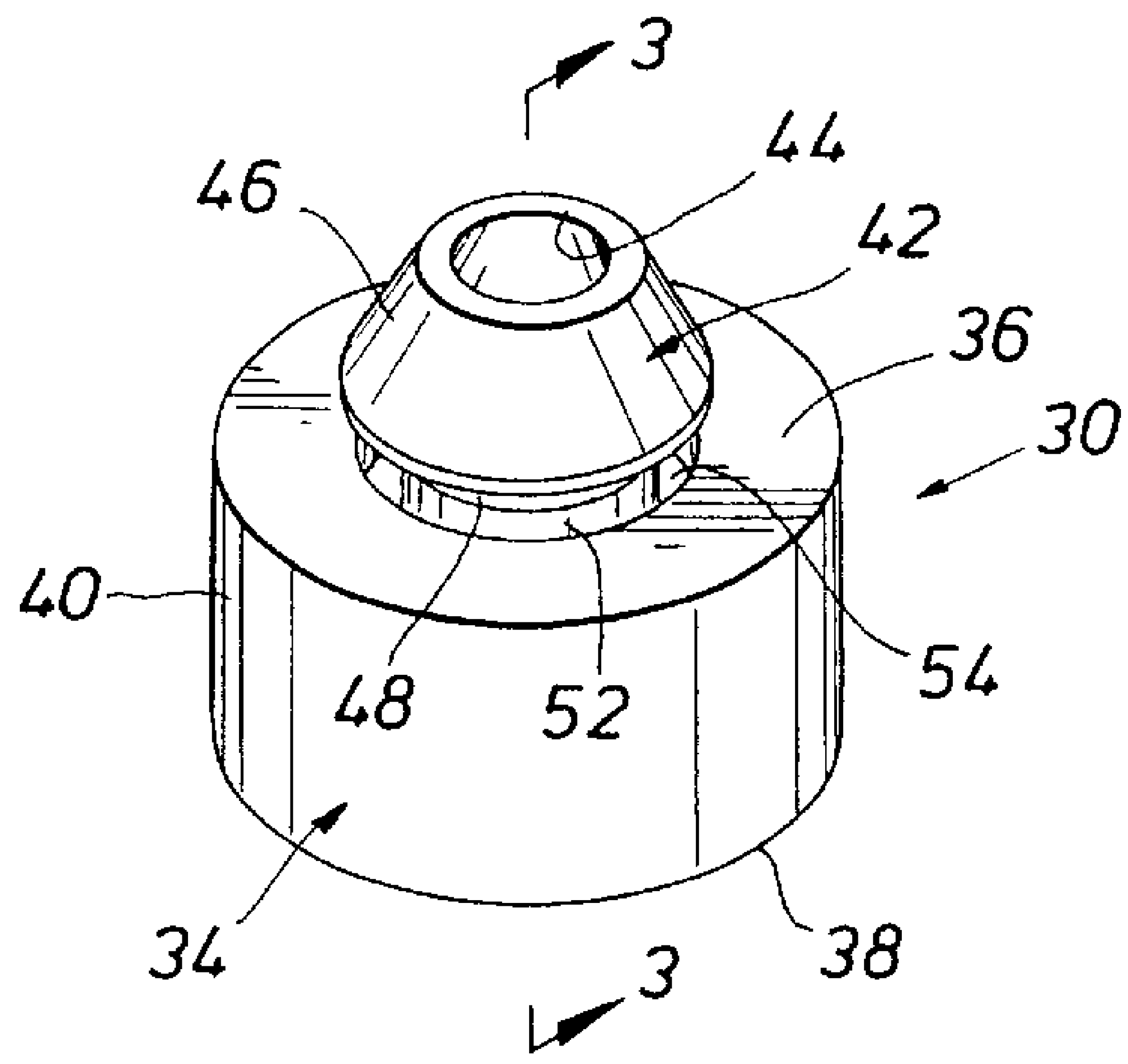
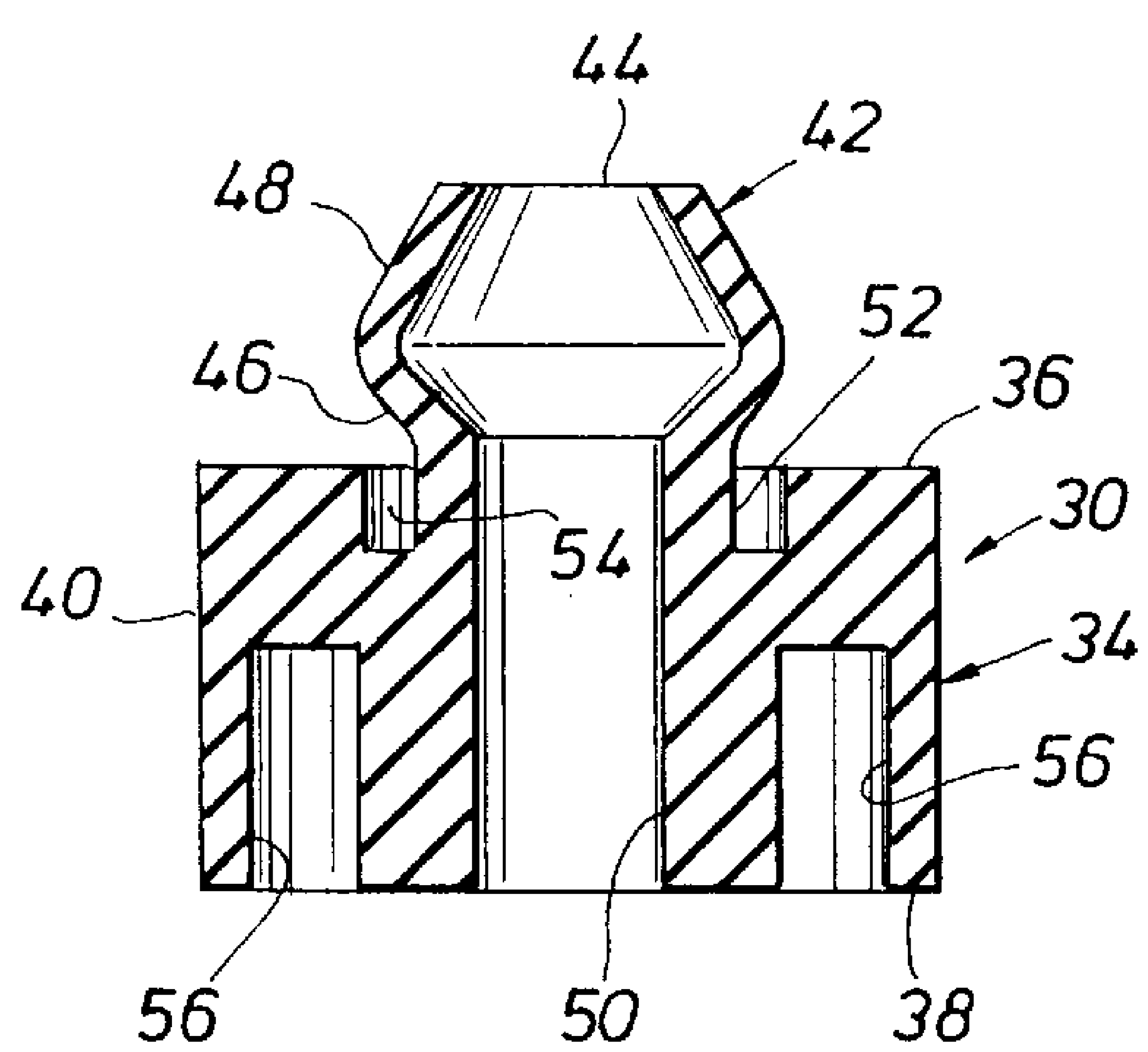


FIG. 2



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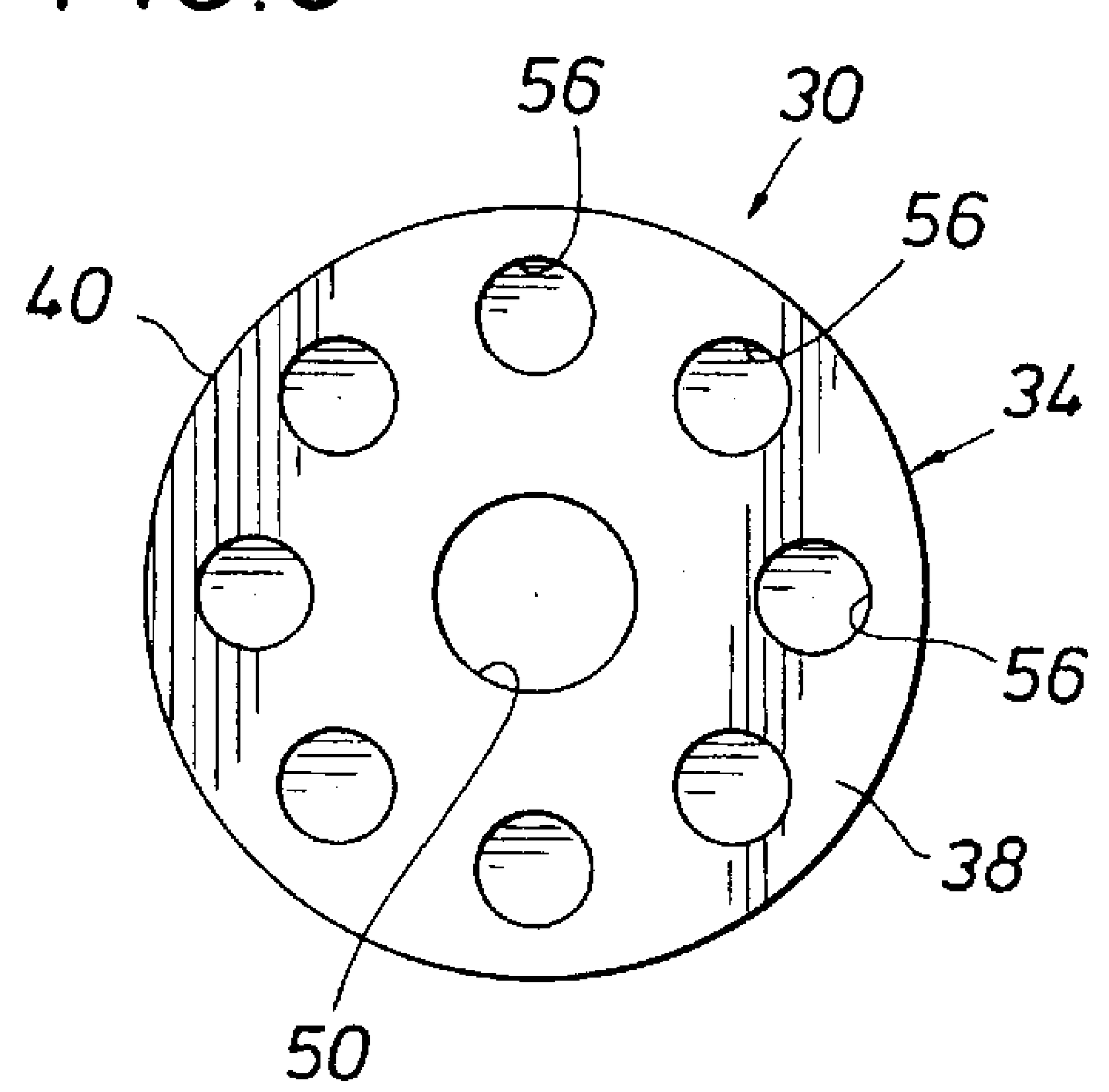
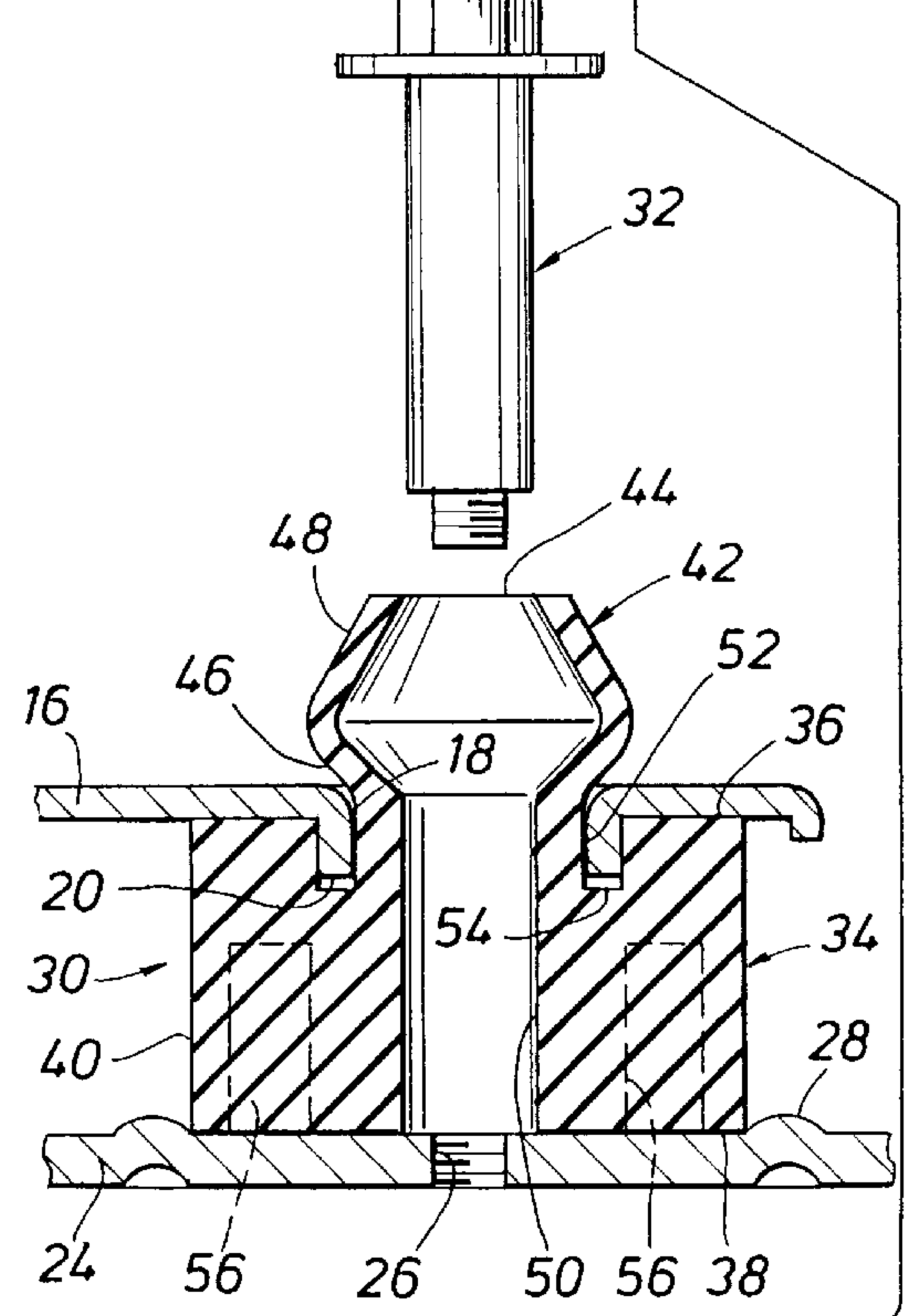


FIG. 4

FIG. 5



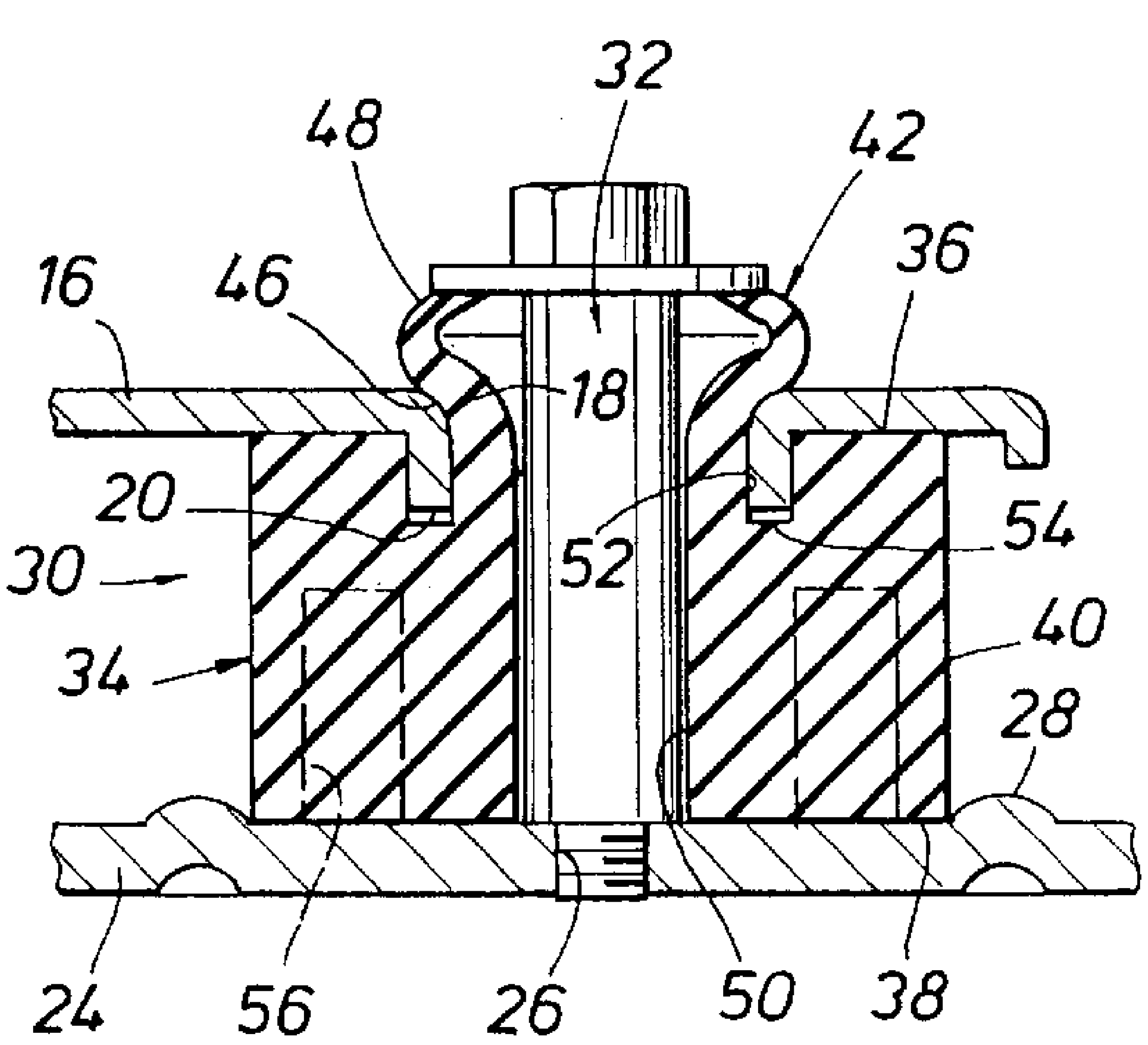
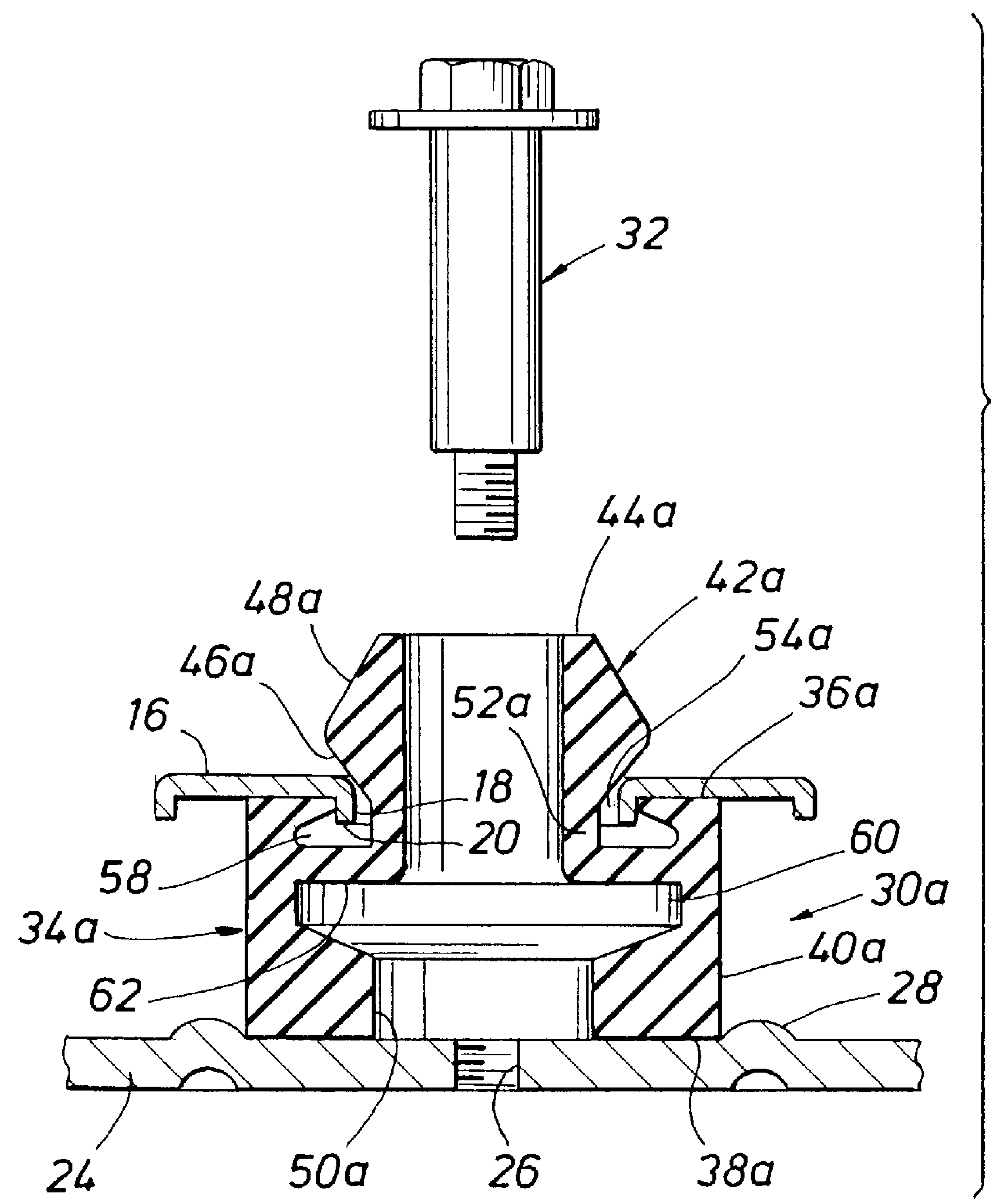


FIG. 6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54a
46a
52a
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58
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34a
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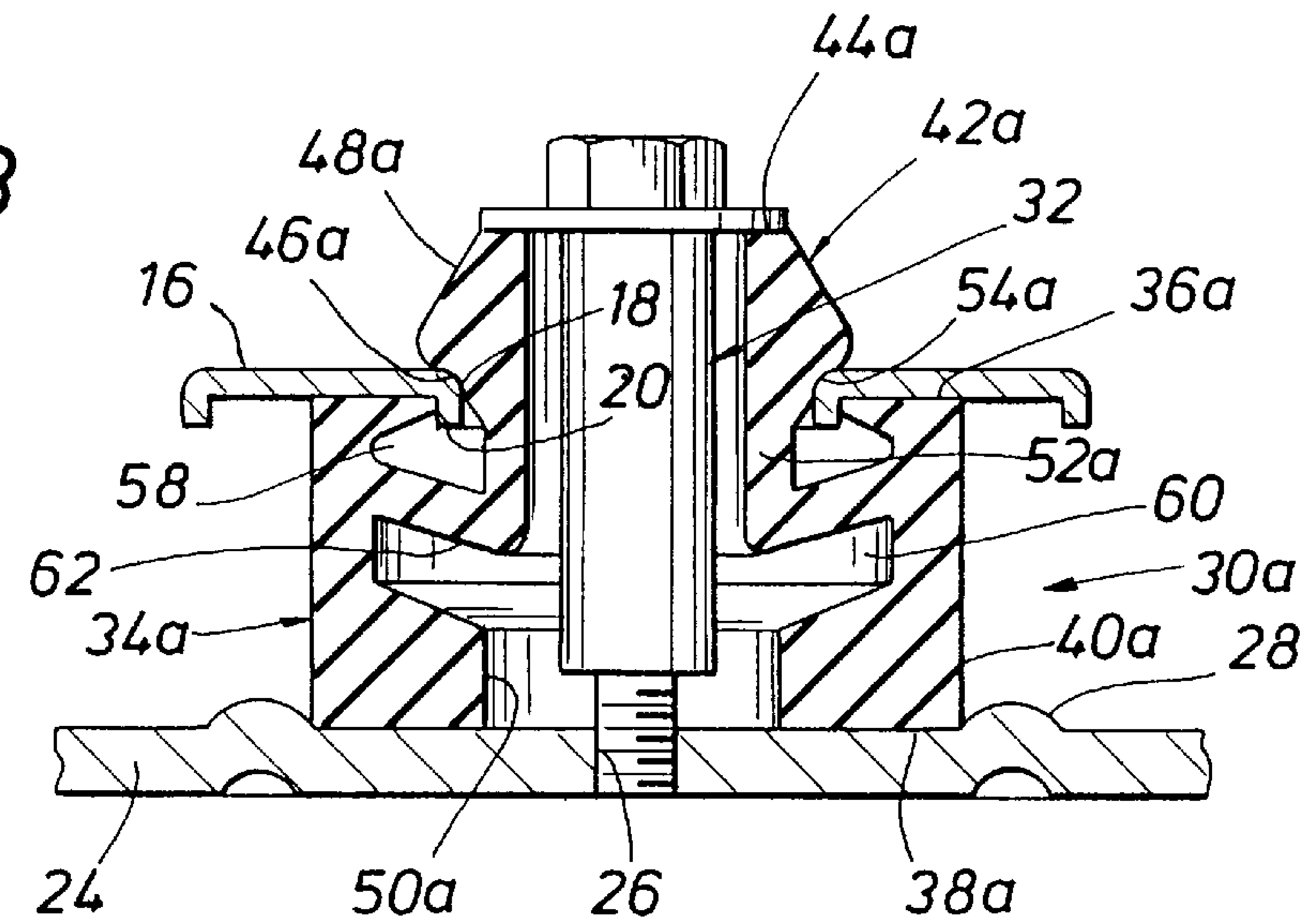
62
28
24
50a
26
38a

FIG. 7

FIG. 8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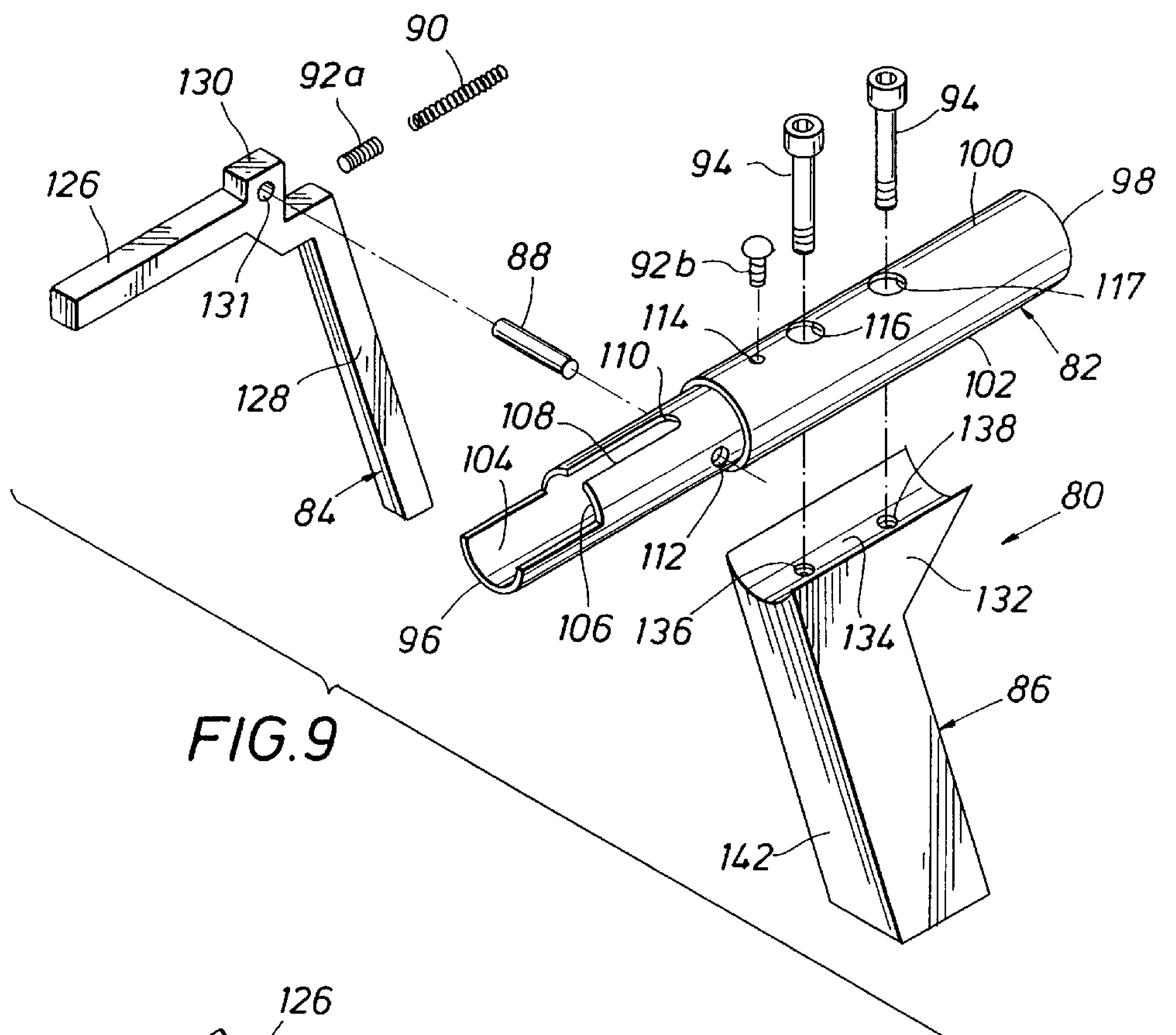
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130
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126
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94
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98
88
92b
117
131
114
116
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80
84
112
132
96
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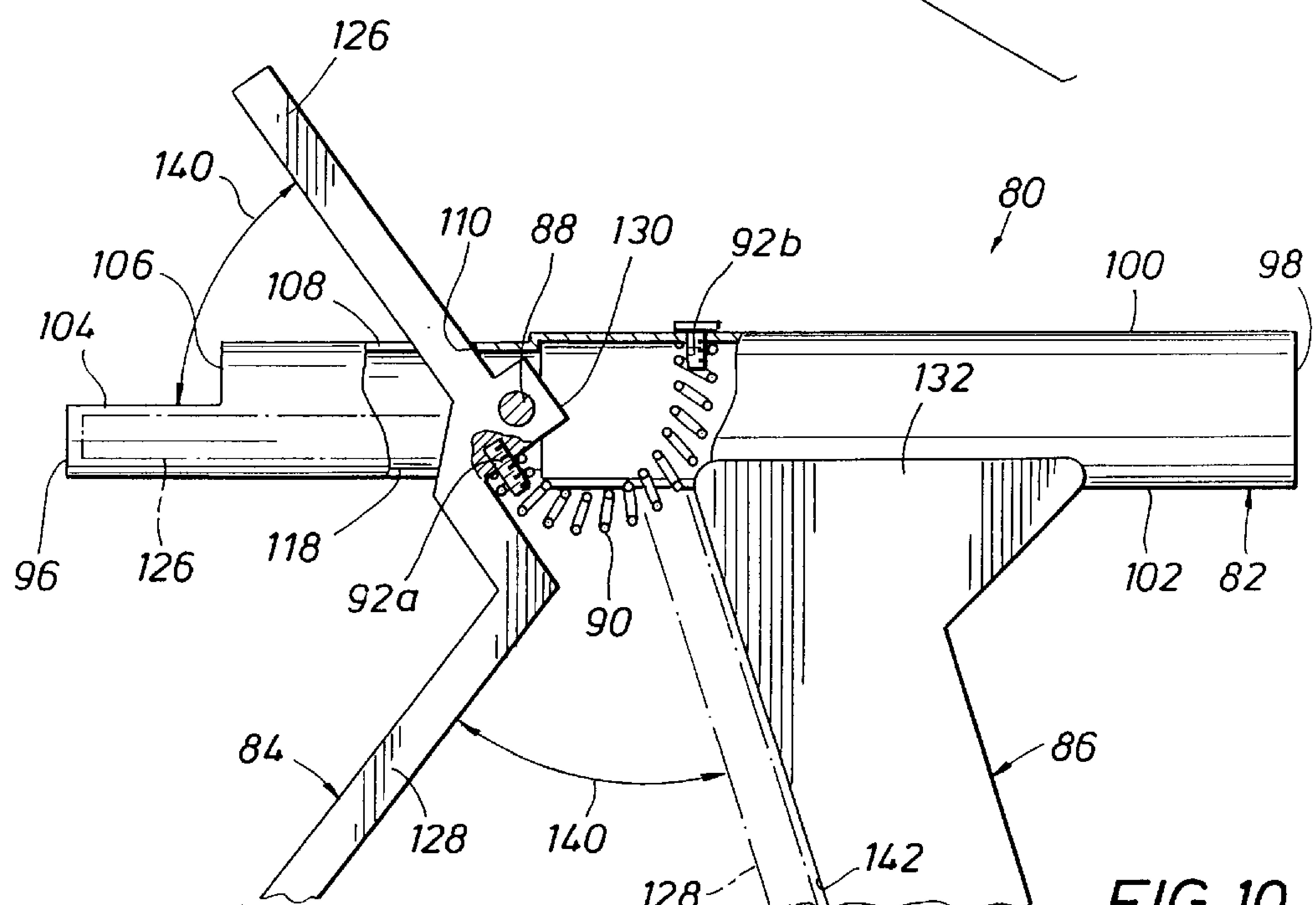
136
134
86
142

FIG.9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92b
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92a
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82
84
86
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140
142
128

FIG.10

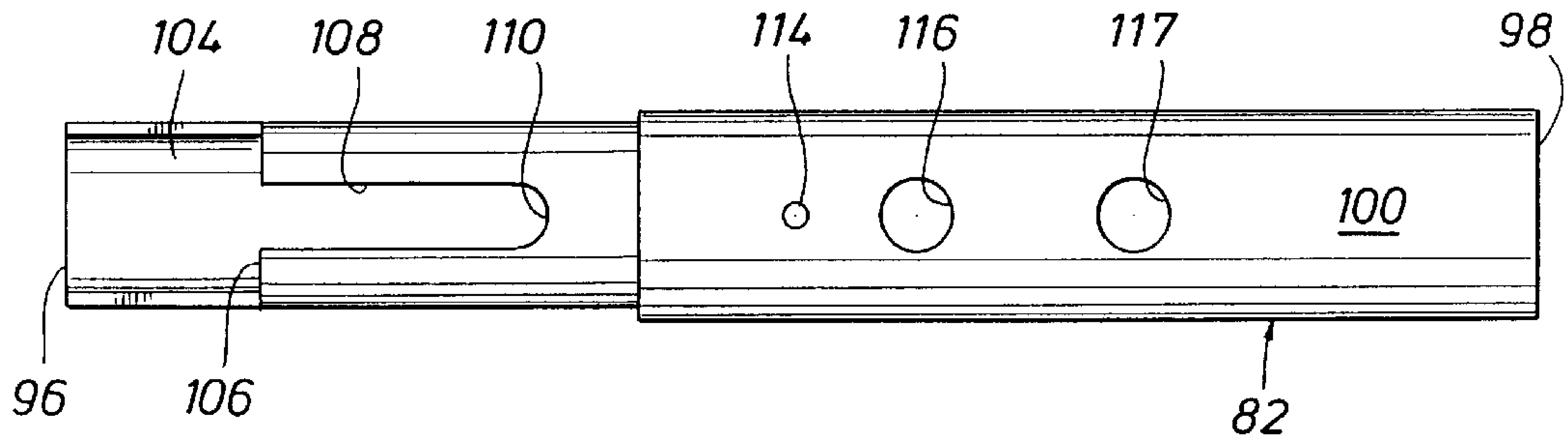


FIG. 11

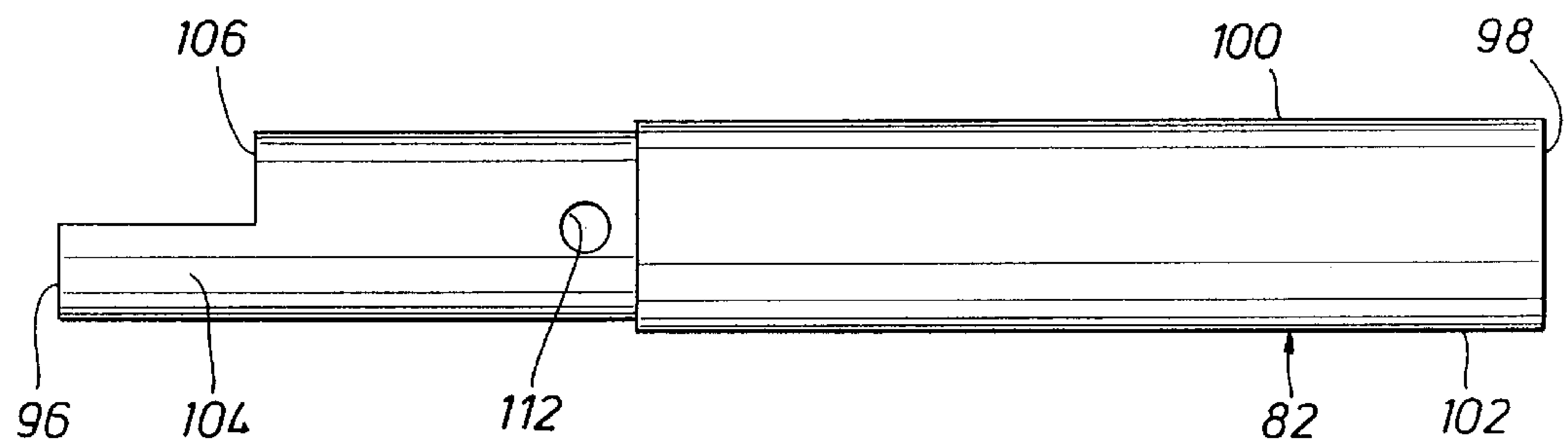


FIG. 12

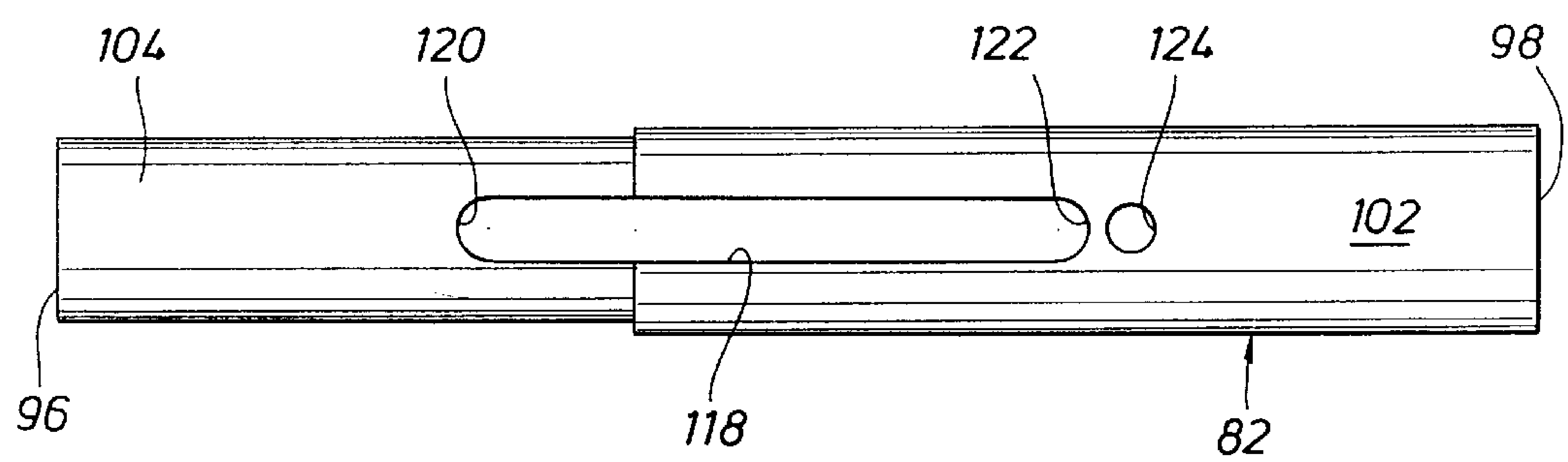


FIG. 13

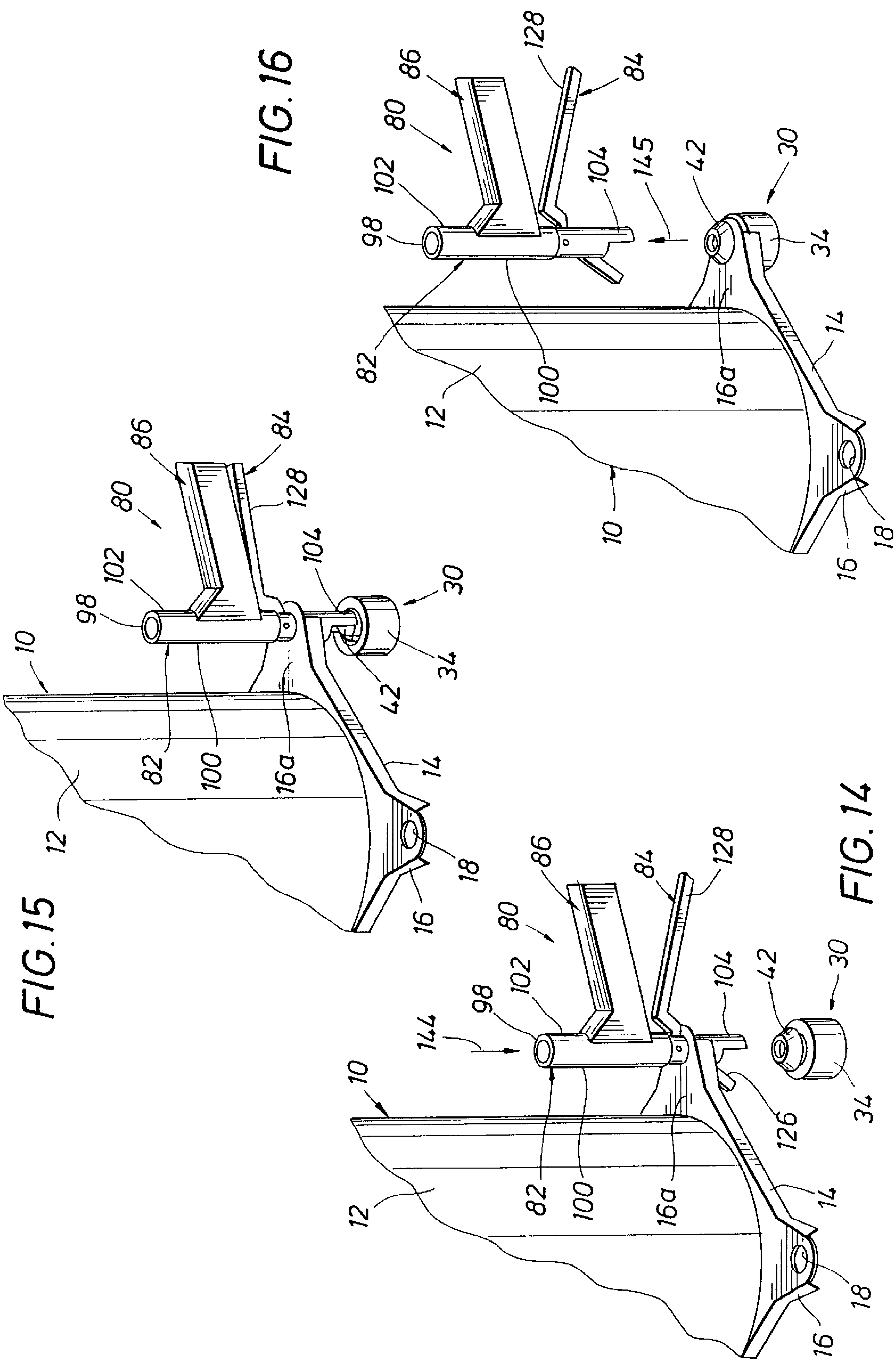
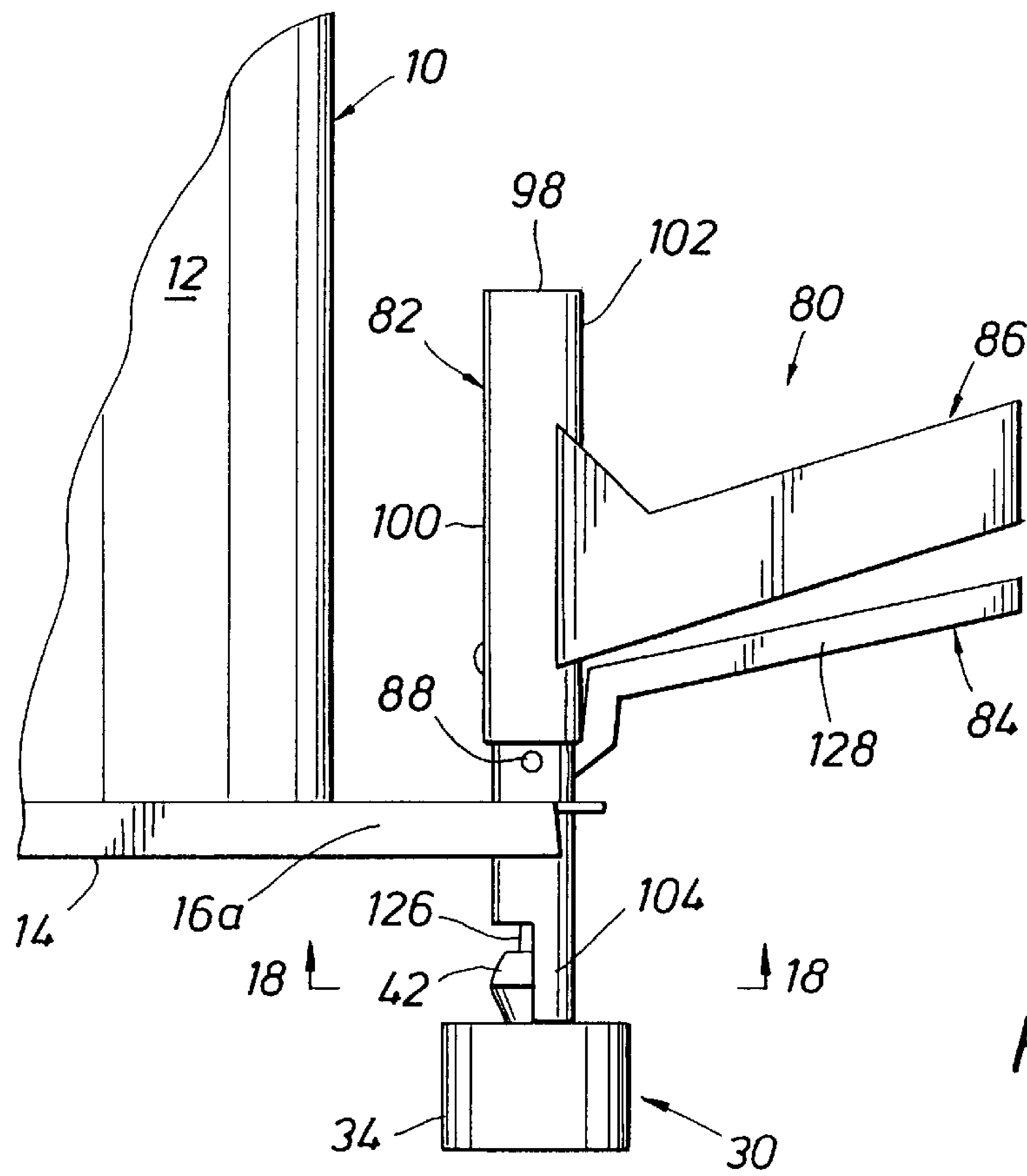


FIG. 15

FIG. 16

FIG. 14


10
12
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128
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14
16a
126
104
18
42
18
34
30

FIG. 17

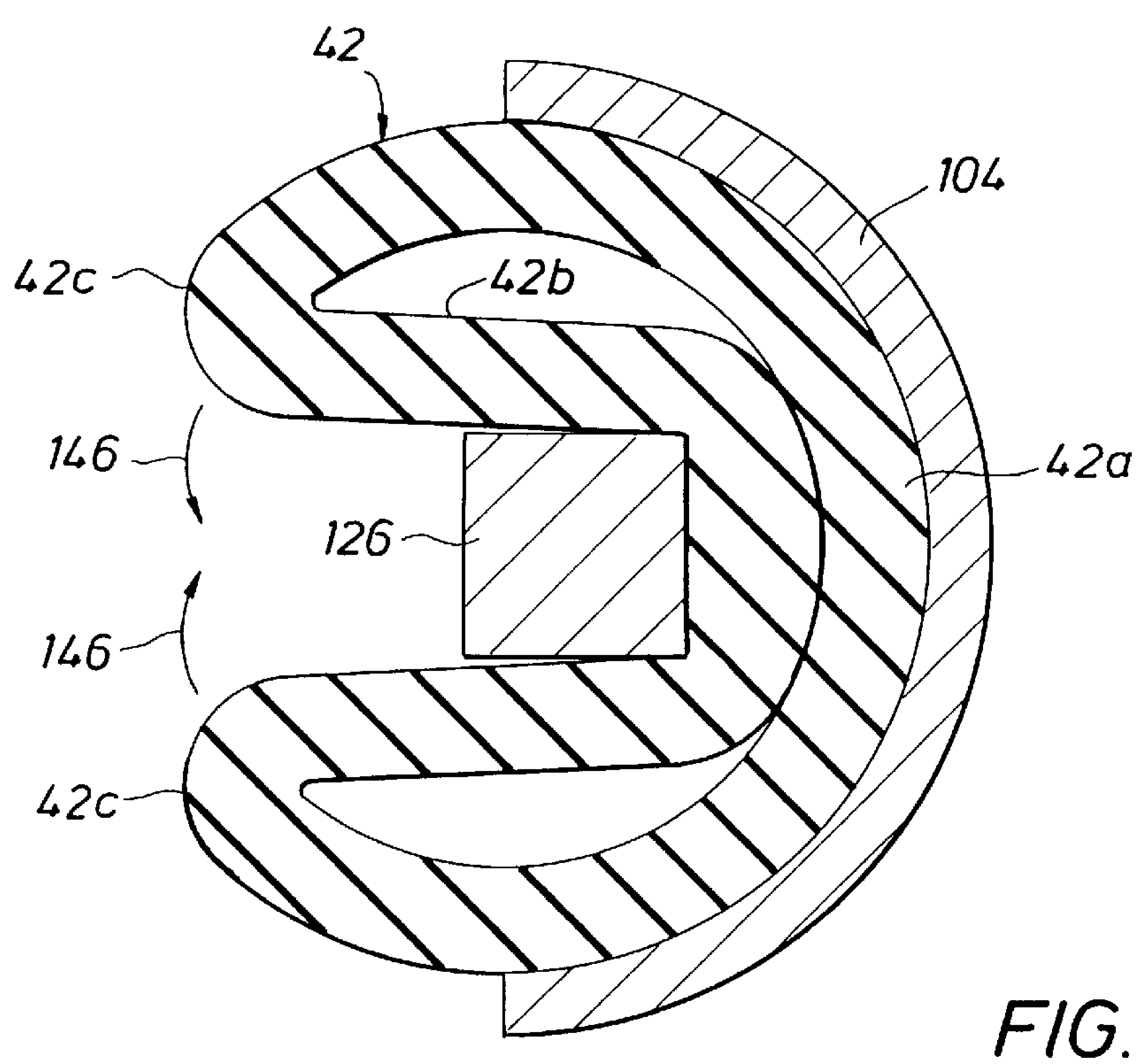
42
104
42c
42b
146
42a
126
146
42c

FIG. 18

PRESTRESSED COMPRESSOR MOUNT INSTALLATION METHODS

CROSS-REFERENCE TO RELATED APPLICATION

This is a CIP of application Ser. No. 08/881,673 filed Jun. 24, 1992, now U.S. Pat. No. 5,964,579.

BACKGROUND OF THE INVENTION

The present invention generally relates to apparatus and methods for resiliently mounting vibration-prone machinery and, in a preferred embodiment thereof, more particularly relates to installation of elastomeric mounting members used to provide vibration absorbing support for the mounting feet portions of a compressor.

Mechanical compressors used, for example, in air conditioning and heat pump systems typically generate a considerable amount of vibration during their operation. In an attempt to isolate the equipment to which the compressor is connected, small resilient devices typically referred to as compressor mounts are used and are operatively interposed between mounting feet portion of the compressor and a support structure, such as a base pan, which underlies the compressor.

In common with various other types of machinery, a mechanical compressor will vibrate and radiate sound when it is excited by an external dynamic force. The radiated sound pressure level is governed by two major factors—the excitation force magnitude and frequency characteristics and the compressor's dynamic characteristics. Accordingly, structural vibration can be reduced by either external dynamic force isolation, structural modification, or both. A structural modification of the compressor to diminish its vibration forces is typically quite complex, and thus undesirable, due to the multi-frequency and multi-directional excitation forces to which the compressor is normally subjected. Accordingly, due to their simplicity and cost effectiveness, elastomeric compressor mounts are widely employed to isolate the compressor's vibration energy from the support structure.

A compressor's natural rigid modes consist of the six degree of freedom motions (three translation motions, two rotating motions, and one torsional motion), but its internal excitations may be limited to only several directions which are dependent on the compressor type. An isolator can be designed to accommodate the forced excitation direction and frequency. For example, a vibration isolation mount designed to isolate translation excitation may not affect rotational excitation isolation, and may not attenuate the overall operation sound level of the compressor.

It is difficult to design a compressor mount to handle all vibration isolation applications because such design would require that the compressor mount and the piping attached to the compressor have a high degree of flexibility in all six directions. And, if this design was incorporated, the compressor assembly would be unstable, undesirably resulting in large deformations of the compressor assembly, damaged piping, stripped compressor bolts and the like. From a practical standpoint, a satisfactory compressor mount would have sound reduction capabilities in addition to having enough stiffness to maintain small start-up tubing stress, system anti-shock capabilities and compressor assembly reliability.

A conventionally configured elastomeric compressor mount typically has a lower cylindrical base portion which

rests on a base pan member, and a smaller diameter head portion projecting upwardly from the base portion, with an annular groove formed generally at the juncture of the base and head portions of the mount. A connection bolt through-hole extends axially through the mount. To support a compressor foot on a conventional elastomeric mount of this general type the mount base portion is placed on the top side of a base pan structure, the mount head portion is passed upwardly through a circular mounting hole in the compressor foot, and an annular bottom side flange on the compressor foot is forced into the annular groove in the mount. A mounting bolt is then extended downwardly through the mount through-hole and threaded into the underlying base pan structure to hold the mount and the associated compressor foot in place.

The mount head portion has a cylindrical upper end portion with a diameter larger than that of the compressor foot hole through which the cylindrical upper end portion of the mount head must be passed. Accordingly, when the compressor foot is operatively placed on the underlying mount base portion, the cylindrical upper end portion of the mount head horizontally overlaps an annular area of the compressor foot surrounding its mounting hole, thereby captively retaining the foot against upward removal thereof from the mount.

Two primary problems have typically been associated with conventional elastomeric compressor mounts of the type generally described above. First, their configurations tend to make them difficult to install on compressor mounting feet since a considerable amount of force is typically required to push the mount head portion upwardly through the mounting hole in the compressor foot. Second, because of their configurations it is often difficult to tighten the mounts onto their captively retained compressor feet in a manner suitably restraining the compressor feet against vertical movement relative to the mounts. This permits the compressor to undesirably "rock" on its underlying mounts in a manner transmitting a substantial amount of operational vibration load to the refrigerant tubing attached to the compressor, as well as to other portions of the air conditioning or heat pump system.

In some previously utilized mounts a vertical gap is intentionally provided between the top side of the installed compressor foot and the underside of the mount head portion to make it easier to place the annular underside flange of the compressor foot into the annular mount groove. While this makes the placement of the compressor feet on their associated elastomeric mounts easier, it also permits the mount-supported compressor even more freedom to rock on the mounts and potentially damage other portions of the overall air conditioning or heat pump system with which the compressor is associated.

In two embodiments thereof illustrated and described in copending U.S. application Ser. No. 08/881,673, (now U.S. Pat. No. 5,964,579) a resilient compressor mount is provided with a relatively thin-walled hollow convex cylindrical head portion having an upper end diameter smaller than that of the compressor foot hole, and a vertically intermediate portion having a maximum diameter substantially greater than the foot hole diameter—representatively about 1.5 times greater. This specially designed mount head portion configuration axially weakens the installed head portion in a manner permitting it to be resiliently squeezed downwardly against the top side of the mounting foot by the overlying head section of the mounting bolt. The resulting vertical deformation and compression of the mount head portion adds desirable axial and horizontal stiffness to the compressor and mount system and provides a substantially linear elastic damping system which enhances the stability of the overall apparatus and resiliently inhibits rocking of the compressor about horizontal axes.

The relatively thin-walled configuration of the convex cylindrical mount member head portion compared to conventionally configured resilient compressor mount head portions permits it to be laterally deformed, to permit its installation passage through its associated compressor foot opening, with somewhat less force. However, due to the fact that the maximum outer diameter of the head portion is about 1.5 times the diameter of the circular mounting foot opening through which it must pass, this necessary lateral deformation tends to be a relatively awkward task using conventional mount installation tools and techniques.

A need thus exists for improved installation apparatus and methods for operatively attaching a resilient compressor mount, of the types generally described above, to an associated compressor foot portion. It is to this need that the present invention is directed.

SUMMARY OF THE INVENTION

In carrying out principles of the present invention, in accordance with a preferred embodiment thereof, a specially designed tool is provided for facilitating the installation movement of an annular head portion of a resilient mount member, such as a compressor mount, through a circular hole disposed in an equipment base structure, such as a compressor foot, having a diameter less than that of the head portion.

From a broad perspective, the tool comprises first and second intersecured portions that may be selectively moved toward and away from one another, and a clamping portion extendable through the circular hole. The clamping portion is secured to the first and second tool portions and is selectively operable thereby to releasably engage circumferentially spaced apart first and second exterior side surface portions of the annular mount member head portion and squeeze them toward one another in a manner laterally deforming the head portion to a generally U-shaped configuration to facilitate its movement by the clamping portion through the circular hole.

The clamping portion of the tool preferably includes first and second pivotally intersecured parts, the first part having a concavely arcuate side surface positionable against a circumferentially extending first outer side surface portion of the mount member head portion, and the second part being supported for selected movement toward and away from the arcuate side surface between a clamping position and a release position.

In the clamping position, the second part is adjacent the arcuate side surface and is positioned to pass through the circular hole with the first part of the clamping portion. In the release position the second part is moved away from the arcuate side surface to permit the mount member head portion to be position between the arcuate side surface and the second part, with the arcuate side surface facing the first outer side surface portion, and the second part positioned outwardly adjacent a second outer side surface portion of the mount member head portion circumferentially spaced apart from the first outer side surface portion thereof.

The second clamping portion part, when moved from the release position to the clamping position with the mount head portion disposed between the arcuate side surface and the second clamping portion part, is cooperable with the arcuate side surface to squeeze the mount head portion therebetween and resiliently deform it laterally to a generally U-shaped configuration to facilitate its passage through the circular hole with the first and second clamping portion parts.

In a preferred method of the invention, the mount head portion has a convex annular configuration, and preferably also has a uniform wall thickness, and the clamping portion of the tool is moved to its clamping position and passed in a first direction through the circular hole. The clamping portion is then opened to its release position, placed over opposite exterior side portions of the mount head and forced back to its clamping position to laterally deform the mount head to the aforementioned generally U-shaped configuration thereof. The clamping portion of the tool is then pulled back through the circular hole, with the deformed mount portion still being clamped by the tool, and then moved to its release position to permit the mount head to spring back to its original undeformed configuration.

In a preferred constructional embodiment thereof, the tool comprises a hollow tubular first member having a front end portion and opposite top and bottom side portions, the front end portion having a circumferential portion thereof removed to expose a concavely arcuate inner side surface section. A depending handle is generally transversely secured to he first member rearwardly of its front end portion.

An elongated second member longitudinally extends through the top and bottom side portions of the first member forwardly of the handle, and is pivotally secured to the first member. The second member has a clamping portion disposed generally above the concavely arcuate inner side surface section, and a trigger portion pivotally movable toward and away from the handle to respectively pivot the clamping portion toward and away from the concavely arcuate inner side surface section. A spring structure interconnected between the first and second members resiliently biases the trigger portion pivotally away from the handle.

To use the tool, the trigger is squeezed and the front end of the first member and the clamping portion of the second member are pushed through the circular hole. The trigger is then released and the mount head is placed between the arcuate side surface section and the clamping portion of the second member. Next, the trigger is squeezed again to laterally deform the mount head to a generally U-shaped configuration, and deformed mount head is pulled through the circular hole. The trigger is then released to disengage the tool from the mount head and permit the released mount head to laterally spring back to its previous undeformed configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of a representative air conditioning or heat pump system compressor which is operatively mounted on a base pan structure using specially designed resilient compressor mounts embodying principles of the present invention;

FIG. **2** is an enlarged scale perspective view of one of the compressor mounts;

FIG. **3** is an enlarged scale cross-sectional view through the compressor mount taken along line **3—3** of FIG. **2**;

FIG. **4** is an enlarged scale bottom plan view of the compressor mount;

FIGS. **5** and **6** are enlarged scale partially elevational cross-sectional views of the compressor mount sequentially illustrating its operative interconnection between a compressor foot and the base pan structure;

FIGS. **7** and **8** are partially elevational cross-sectional views through an alternate embodiment of the compressor mount and sequentially illustrate its operative interconnection between a compressor foot and the base pan structure;

FIG. **9** is an exploded perspective view of a specially designed clamping tool embodying principles of the present invention and used to install one of the resilient compressor mounts;

FIG. **10** is a partially cut away, vertically foreshortened side elevational view of the assembled tool;

FIG. **11** is a top plan view of a tubular body portion of the tool;

FIG. **12** is a side elevational view of the tool body;

FIG. **13** is a bottom plan view of the tool body;

FIGS. **14–16** are reduced scale perspective views of the tool sequentially illustrating its use in installing a resilient mount on a compressor foot;

FIG. **17** is an enlarged scale side elevational view of the tool in its FIG. **15** orientation; and

FIG. **18** is an enlarged scale cross-sectional view through the tool, and an upper portion of the compressor mount, taken along line **18—18** of FIG. **17**.

DETAILED DESCRIPTION

Perspectively illustrated in exploded form in FIG. **1** is a representative mechanical compressor **10** used in, for example, an air conditioning or heat pump system and being operatively connected to associated refrigerant tubing (not shown) in a conventional manner. Compressor **10** has a vertically oriented cylindrical body portion **12** at the bottom of which a generally rectangular support structure **14** is secured. The support structure **14** has, at each of its four corners, an outwardly projecting foot portion **16** (only three of the compressor feet being visible in FIG. **1**) having a circular opening **18** formed therein. Each opening **18** is circumscribed by an annular flange **20** (see FIG. **5**) depending from the bottom side of the foot **16**. A base pan structure **22** having a bottom wall **24** underlies the compressor **10**, the bottom wall **24** having four mounting holes **26** which are horizontally alignable with the compressor foot openings **18** and are outwardly ringed by arcuate guide embossments **28** formed on the top side of the bottom base pan wall **24**.

Compressor **10** is resiliently supported atop the bottom base pan wall **24** by four specially designed vibration attenuating resilient compressor mounts **30** (only three of which are visible in FIG. **1**) which embody principles of the present invention and are interposed between the compressor feet **16** and the bottom base pan wall **24**, and secured thereto by vertical bolts **32**, in a manner subsequently described herein. Preferably, the mounts **30** are molded as one piece structures from a suitable elastomeric material.

Turning now to FIGS. **2–4**, each mount **30** has a cylindrical lower base portion **34** with an annular top end **36**, an annular bottom end **38**, and an annular vertical outer side **40**. Projecting axially upwardly beyond the top end wall **36** is a hollow convex cylindrical head portion **42** of the mount **30** which has an open upper end **44**, an upwardly and radially outwardly sloped bottom side wall **46**, and an upwardly and radially inwardly sloped top side wall **48**. An axially extending circularly cross-sectioned tightening opening **50** passes upwardly through the bottom base portion end **38** into the head portion interior which forms a laterally enlarged upward extension of the tightening opening.

The mount head portion **42** has a substantially uniform wall thickness, and is joined at its bottom end to the top end of the mount base portion **34** by an annular intermediate section **52** of the mount which is outwardly circumscribed by an annular groove **54** formed in the top base portion end wall **36** and underlying the sloping bottom side wall **46** of the mount head portion **42**. Preferably, the diameter of the convex cylindrical mount head portion **42** at its upper end is less than the diameter of each support foot opening **18**, while the maximum diameter of the head portion **42** is approximately 1.5 times the support foot opening diameter.

As best illustrated in FIGS. **3** and **4**, a circumferentially spaced series of circularly cross-sectioned holes **56** surround the tightening hole **50** and extend upwardly through the bottom end **38** of the mount base portion **34**. These holes serve to facilitate the mount molding process by maintaining a generally uniform elastomeric material thickness in the base **34**, thereby maintaining a generally uniform thermal stress during molding, and additionally reducing the material cost of the mount.

Each compressor foot **16** is operatively installed on the bottom base pan wall **24**, in an upwardly spaced relationship therewith, using one of the vibration attenuating elastomeric mounts **30** in a manner which will now be described in conjunction with FIGS. **5** and **6**. The hollow, convex cylindrical head portion **42** of each mount **30** is laterally deformed, in a unique manner later described herein, and then passed upwardly through its associated foot opening **18** in a manner causing the bottom side of the foot **16** to downwardly engage the top end **36** of the mount base portion, and the depending annular flange portion **20** of the foot to enter the annular mount groove **54**. The laterally deformed head portion **42** is then allowed to spring back to its original shape, as shown in FIG. **5**, in which the radially enlarged axially central portion of the head **42** outwardly overlies a corresponding annular portion of the compressor foot **16**.

The bottom end **38** of each mount **30** is placed on the top side of the bottom base pan wall **24**, within one of the arcuate embossments **28** thereon, and one of the bolts **32** is axially extended downwardly through the mount **30** and threaded into the underlying base pan mounting hole **26** as illustrated in FIG. **6**. The cylindrical body portion of each bolt **32** is shorter than the total undeformed height of its associated elastomeric mount. Thus, when the bolt is tightened into the base pan wall **24** the enlarged head portion of the bolt moves the hollow convex cylindrical mount head portion **42** toward the upper end **36** of the mount base portion **34** by axially compressing the head portion **42**, while at the same time radially outwardly deforming it. This, in turn, resiliently squeezes an annular portion of the compressor foot **16** outwardly adjacent the foot opening **18** between the bottom side surface **46** of the deformed mount head portion **42** and the top end **36** of the mount base portion **34** as shown in FIG. **6**.

The unique configuration of each elastomeric compressor mount **30** provides it with several advantages over conventionally configured mounts used in this particular application. For example, the mount **30** is considerably easier to install on its associated compressor foot **16** due to the hollow, thin-walled head portion **42** of the mount which may be easily compressed in a lateral (i.e., horizontal) direction to facilitate its upward passage through the mounting hole **18** in the foot **16**. Additionally, the upward and radially outward slope of the bottom side wall **46** of the mount head portion **42** provides an enlarged entrance area for the underlying annular groove **54** to make it easier to insert the depending compressor foot flange **20** into the groove.

Moreover, the provision of the hollow convex cylindrical head portion **42** on the mount **30** axially weakens it in a manner permitting the head portion **42** to be moved downwardly toward the mount base portion **34** (as may be seen by comparing FIGS. **5** and **6**), to resiliently squeeze an annular portion of the installed compressor foot **16** between the bottom side wall **46** of the mount **30** and the upper end **36** of the mount base portion **34**, without creating a substantial compressive force in the annular intermediate section **52** of the mount. With the mount head portion **42** laterally deformed and pressed down onto the compressor foot **16** in this manner, the mount **30** adds axial and horizontal stiffness to the compressor and mount system and provides a substantially linear elastic damping system which enhances the stability of the overall apparatus and resiliently inhibits rocking of the compressor **10** about horizontal axes.

An alternate embodiment **30***a* of the previously described elastomeric compressor mount **30** is cross-sectionally illustrated in FIGS. **7** and **8**. For ease in comparison, features and components in the mount **30***a* similar to those in the mount **30** have been given identical reference numerals having the subscript "a".

The elastomeric mount **30***a* has a cylindrical lower base portion **34***a* with an annular top end **36***a*, an annular bottom end **38***a*, and an annular vertical outer side **40***a*. Projecting axially upwardly beyond the top end wall **36***a* is a hollow convex cylindrical head portion **42***a* of the mount **30***a* which has an open upper end **44***a*, an upwardly and radially outwardly sloped bottom side wall **46***a*, and an upwardly and radially inwardly sloped top side wall **48***a*. An axially extending circularly cross-sectioned tightening opening **50***a* passes upwardly through the bottom base portion end **38***a* into the head portion interior which forms a radially reduced, circularly cross-sectioned upward extension of the tightening opening **50***a*. Unlike the previously described mount head portion **42**, the head portion **42***a* has a nonuniform wall thickness as cross-sectionally illustrated in FIGS. **7** and **8**.

An enlarged diameter annular groove **58** is interiorly formed within the mount base portion **34***a* and forms a downward continuation of the smaller diameter annular groove **54***a* at the top end of the base portion **34***a*. A vertically thicker annular groove **60** is formed in the interior side surface of the mount base portion **34***a* and is spaced downwardly apart from the annular groove **58**. Positioned between the annular grooves **58** and **60** within the mount base portion **34***a* is an annular internal flange portion **62** of the mount **30***a*. As illustrated in FIGS. **7** and **8** the annular intermediate mount section **52***a*, to which the head portion **42***a* is attached, extends upwardly from a central annular portion of the internal flange **62**.

To install the mount **30***a*, its convex cylindrical head portion **42***a* is laterally deformed, in a unique manner subsequently described herein, and passed upwardly through the hole **18** in the compressor foot **16** and then allowed to snap back to its original undeformed configuration, and the bottom end **38***a* of the mount base portion **34***a* is placed on the base pan wall **24**, within the arcuate embossment **28**, as shown in FIG. **7**. Next, as indicated in FIG. **8**, the bolt **32** is extended downwardly through the tightening opening **50***a* in the mount **30***a* and threaded into the base pan opening **26**. This forces the mount head portion **34***a* downwardly toward the upper end **36***a* of mount base portion **34***a*, thereby downwardly deflecting the annular internal flange **62** and resiliently squeezing an annular portion of the compressor foot **16** circumscribing its mounting opening **18** between the bottom side **46***a* of the mount head portion **42***a* and the top end **36***a* of the mount base portion **34***a* as cross-sectionally illustrated in FIG. **8**.

The connection of the intermediate mount section **52***a* to the resiliently and downwardly deflectable annular internal flange **62** thus axially weakens the mount **30***a* in a manner permitting the annular compressor foot portion to be resiliently squeezed between the mount base and head portions **34***a*,**42***a* without imposing a substantial amount of compressive force on the annular intermediate section **52***a* of the mount **30***a*.

While the elastomeric mounts **30** and **30***a* have been illustrated as being representatively installed on a compressor in an air conditioning or heat pump system, it will be readily appreciated by those of skill in this particular art that they could also be advantageously utilized in conjunction with many other types of vibration-prone machinery in other types of mechanical systems.

As previously discussed herein, the unique convex cylindrical configurations of each of the head portions **42**,**42***a* of the compressor mounts **30** and **30***a*, and their laterally overlying installed relationships with the top side of their associated compressor foot **16**, permits the head portion to be vertically deformed and squeezed against the top side of its associated mounting foot **16**. This, in turn adds axial and horizontal stiffness to the compressor and mount system and provides a substantially linear elastic damping system that enhances the stability of the overall apparatus and resiliently inhibits the rocking of the compressor **10** about horizontal axes.

The relatively thin-walled configurations of the convex cylindrical mount member head portions **42** and **42***a* compared to conventionally configured resilient compressor mount head portions permits them to be laterally deformed, to permit their installation passage through one of the compressor foot openings **18**, with somewhat less force. However, due to the fact that the maximum outer diameter of each head portion **42**,**42***a* is representatively about 1.5 times the diameter of each circular mounting foot opening **18**, this necessary lateral deformation tends to be a relatively awkward task using conventional mount installation tools and techniques.

Referring initially to FIGS. **9**–**13**, this installation problem is substantially alleviated using a specially designed installation clamping tool **80** embodying principles of the present invention. As perspectively illustrated in exploded form in FIG. **9**, the tool **80** comprises a hollow tubular body **82**; a generally L-shaped clamping bar member **84** having a rectangular cross-section along its length; a handle **86**; a cylindrical pivot dowel **88**; a coiled compression spring member **90**; two all-thread screws **92***a* and **92***b*; and two Allen screws **94**.

The hollow tubular body **82** has a front end **96**, a rear end **98**, a top side **100**, and a bottom side **102**. A front end portion of the body **82** has a top side section removed therefrom in a manner leaving an arcuate, upwardly concave front end portion **104** circumferentially extending through a somewhat greater than semicircular arc. The outer diameter of the body **82** is somewhat less than the diameter of the holes **18** in the compressor mounting feet **16** (see FIG. **1**). Above the rear or inner end of the front end portion **104** is an upwardly curved ledge **106**. Axially extending rearwardly from the ledge **106** through a top side portion of the body **82** is a slot **108** having a curved rear end surface **110** positioned slightly forwardly of a diametrically opposed pair of circular dowel holes **112** extending through left and right side portions of the body **82**. To the rear of the top side slot **108** a small diameter circular hole **114**, and a pair of larger diameter circular holes **116**,**117** extend through the top side **100** of the tubular body **82**.

An axially extending slot **118** (see FIG. **13**) is formed in the bottom side **102** of the tubular body **82**. The slot **118** has curved front and rear ends **120**,**122** and is spaced slightly forwardly of a circular hole **124** that is formed in the bottom side **102** of the body **82**, underlies the hole **117** in the top side **100** of the body **82**, and has a diameter smaller than that of the hole **117**.

The clamping bar member **84** is of a generally L-shaped configuration and has an elongated clamping arm portion **126**, an elongated trigger arm portion **128**, and a generally rectangular mounting block portion **130** positioned adjacent the juncture of the arms **126**,**128** and having a circular dowel opening **131** extending therethrough. Illustratively, the clamping bar member **84** has a rectangular cross-section along its length and, like the tubular body **82**, is representatively formed from a metal material.

Handle **86** is representatively formed from a suitable plastic material, and has a vertically elongated rectangular configuration with a top end portion **132** that is horizontally enlarged in a front-to-rear direction and provided with a downwardly curved top side surface **134** in which a spaced pair of vertical screw holes **136**,**138** are formed. The tubular body **82** is secured to the handle top side surface **134** by placing a rear bottom side portion of the body **82** on the handle surface **134**, extending the Allen screws **94** downwardly through the body top side openings **116** and **117**, through the interior of the body **82** and downwardly through the bottom side slot **118** and bottom side hole **124** (see FIG. **13**) and then threading the screws **94** into the handle screw holes **136**,**138**. The diameters of the heads of the screws **94** are smaller than the diameters of the body top side holes **116**,**117** but larger than the diameter of the bottom side hole **124** and the width of the bottom side slot **118**. Accordingly, the heads of the screws **94** come to rest on bottom interior side surface portions of the body **82** over its bottom side slot **118** and the bottom side hole **124**.

As best illustrated in FIG. **10**, the clamping bar member **84** extends through the interior of the tubular body **82** forwardly of the handle **86**, with the clamping arm portion **126** extending outwardly through the body top side slot **108**, the mounting block portion **130** disposed within the interior of the body **82**, and the trigger arm portion **128** extending outwardly through the body bottom side slot **118**. The dowel **88** extends transversely through the interior of the tubular body **82**, is rotatable received within the circular opening **131** in the mounting block portion **130**, and has opposite ends that are press-fitted into the dowel holes **112** on the opposite right and left sides of the tubular body **82**.

This permits the installed clamping bar member **84** to rotate about the dowel **88** relative to the balance of the tool **80**, as indicated by the double-ended arrows in FIG. **10**, between the solid line first or unclamped position of the bar member **84** shown in FIG. **10** and a dotted line second or clamping position of the bar member also shown in FIG. **10**. When the clamping bar member **84** is pivoted from its solid line position to its dotted line position, the clamping arm portion **126** pivots downwardly through the upper body side slot **108** and into the interior of a front end portion of the body **82**, and the trigger arm portion **128** pivots rearwardly against the front side **142** of the handle **86**.

As best illustrated in FIG. **10**, the screw **92***a* has its head portion removed, is threaded into a lower rear side section of the mounting block portion **130** of the clamping bar member **84**, and projects rearwardly from the mounting block portion **130**. The screw **92***b* is threaded downwardly into the body top side hole **114** and projects downwardly into the interior of the body **82**. A left end portion of the compression spring member **90** is telescoped over the outwardly projecting end portion of the screw **92***a*, a right end portion of the spring member **90** is telescoped over the downwardly projecting portion of the screw **92***b*, and longitudinally intermediate portion of the spring member **90** laterally projects downwardly through the body bottom side slot **118**. The installed spring member **90** functions to resiliently bias the clamping bar member **84** in a clockwise direction about the dowel **88** toward the solid line position of the clamping bar member **84** in which the engagement of its clamping arm portion **126** with the inner end **110** of the body top side slot **110** stops further clockwise pivotal movement of the clamping bar member **84** relative to the balance of the tool **80**.

The unique manner in which the tool **80** is used to install the resilient mount **30** on one of the compressor feet **16**, for example the compressor foot **16***a*, will now be described in conjunction with FIGS. **14**–**18**. Referring first to FIG. **14**, to start the procedure the operator grasps the tool handle **86** and squeezes the trigger arm portion **128** back toward the handle **86** to bring the clamping bar member **84** to its dotted line second position shown in FIG. **10**. Then, as indicated by the arrow **144** in FIG. **14**, the arcuate front end portion **104** of the tool body **82** (with the clamping arm portion **126** nested therein) is inserted downwardly through the opening **18** in the compressor foot **16***a* and the trigger arm **128** is released to permit the spring **90** to return the clamping bar member **84** to its unclamped position shown in FIG. **14**.

Next, a side section **42***a* of the mount head portion **42** is laterally placed in the arcuate body portion **104** (see FIG. **18**), and the trigger arm portion **128** is upwardly squeezed to forcibly pivot the clamping arm portion **126** into a central portion of the arcuate body front end portion **104** as shown in FIGS. **15**, **17** and **18**. This pivoting of the arm portion **126** into the arcuate front body end portion **104** clamps an opposite side portion **42***b* of the resilient mount head portion **42** inwardly against the inner side surface of the mount side portion **42***a* and deforms the mount head portion **42** to a generally U-shaped configuration as cross-sectionally viewed along the longitudinal axis of the resilient mount. The deformed, generally U-shaped resilient mount head portion **42** shown in FIG. **18** has two leftwardly facing outer or free end portions **42***c*.

It should be noted that the arcuate front body portion **104** serves to brace the side portion **42***a* of the mount head **42** generally in its original convex configuration, while the clamping arm portion **126** serves to reverse the curvature of the mount head side portion **42***b* (to a concave curvature from its original convex curvature) and deform the mount head side portion into nesting engagement with the mount head portion **42***a* to impart to the mount head portion **42** its generally U-shaped configuration shown in FIG. **18**.

As shown in FIG. **16**, with the mount head section **42** still clamped in its FIG. **18** generally U-shaped configuration by the tool **80**, the tool **80** is lifted upwardly away from the top side of the compressor foot **16***a* (as indicated by the arrow **145**) to pull the clampingly deformed mount head portion **42** upwardly through the circular hole **18** in the mounting foot **16***a*. The generally U-shaped configuration imparted to the resilient mount head portion **42** by the tool **80** as shown in FIG. **18** facilitates the upward movement of the head portion **42** through the mounting foot hole **18** by permitting side edge portions of the hole **18** to deflect the outer end portions **42***c* of the deformed head portion **42** toward one another, as indicated by the arrows **146** in FIG. **18**, in a manner further reducing the cross-sectional area of the deformed mount head portion **42** and permitting its upward passage through the mounting foot hole **18**.

Finally, as indicated in FIG. **16**, the trigger arm **128** is released to unclamp the resilient mount head portion **42** and permit it to radially snap back to its original undeformed configuration in which it outwardly overlies a substantial annular top side portion of the mounting foot **16***a* circumscribing its associated circular hole **18** through which the mount head portion **42** was just upwardly passed using the clamping tool **80** of the present invention.

While the tool **18** has been illustrated and described as being used in conjunction with the resilient mount **30**, it will be readily appreciated that it also could be used in conjunction with the resilient mount **30***a*. Additionally, while the tool **80** is particularly useful with these specially configured resilient compressor mounts, it will also be appreciated by those of skill in this particular art that the tool could also be used to advantage with conventionally configured resilient mounts having nonconvex annular head portions, as well as with resilient mounts for vibration prone equipment other than compressors.

The foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims.

What is claimed is:

1. A method of installing a resilient mounting member on an equipment base structure having a circular opening extending between first and second sides thereof, the mounting member having an annular end portion centered about an axis and having a maximum outer diameter greater than the diameter of the circular opening, and an annular outer side surface, said method comprising the steps of:

providing a mounting member installation tool having a clamping portion;

forcibly engaging circumferentially spaced apart outer side surface portions of the mounting member annular end portion with said clamping portion of said tool in a manner laterally and resiliently deforming the end portion to a generally U-shaped configuration bent around the mounting member axis;

axially moving the laterally deformed mounting member end portion, and said clamping portion of said tool engaging it, through the opening from the first side of the base structure to the second side thereof; and

disengaging said clamping portion of said tool from the moved and laterally deformed mounting member end portion in a manner permitting it to laterally spring back to its original configuration and overlie the second side of the base structure.

2. The method of claim **1** wherein said method further comprises the step, performed prior to the performance of said forcibly engaging step, of passing said clamping portion of said tool through said opening from said second side thereof to said first side thereof.

3. The method of claim **1** wherein:

said clamping portion of said tool has a first member having a concavely arcuate surface, and a second member supported for selected clamping movement toward and away from said arcuate surface, and

said forcibly engaging step is performed by placing said arcuate surface externally against a first outer side surface portion of said annular mounting member end portion and placing said second member externally against a second outer side surface portion of said annular mounting member end portion circumferentially spaced apart from said first outer side surface portion, and then forcibly creating a relative clamping movement between said first and second members to laterally deform said annular mounting member end portion to said generally U-shaped configuration thereof.

4. The method of claim **1** wherein:

the resilient mounting member is a resilient compressor mount,

the equipment base structure includes a compressor foot structure in which the circular opening is formed, the circular opening extending between top and bottom sides of the foot structure, and

said axially moving step is performed by moving the deformed mounting member end portion through the opening toward said top side of the foot structure.

5. A method Of resiliently supporting a vibration-prone machine having a support portion with a circular opening extending therethrough between first and second sides thereof, said method comprising the steps of:

providing a resilient mounting member having a hollow convex cylindrical head portion centered about a longitudinal axis of said mounting member and having a maximum diameter greater than the diameter of the circular support portion opening;

providing a mounting member installation tool having a clamping portion;

forcibly engaging circumferentially spaced apart outer side surface portions of said head portion with said clamping portion of said installation tool in a manner laterally and resiliently deforming said head portion to a generally U-shaped configuration bent around said longitudinal axis;

axially moving the laterally deformed mounting member head portion, and said clamping portion engaging it, through the opening from the first side of the support portion to the second side thereof; and

disengaging said clamping portion of said tool from the moved and laterally deformed mounting member head portion in a manner permitting it to laterally spring back to its original configuration and overlie the second side of said support portion.

6. The method of claim **5** wherein:

said step of providing a resilient mounting member includes the step of configuring said hollow convex cylindrical head portion to have a substantially uniform wall thickness.

7. The method of claim **5** wherein said method further comprises the step, performed prior to the performance of said forcibly engaging step, of passing said clamping portion of said tool through said opening from said second side thereof to said first side thereof.

8. The method of claim **5** wherein:

said clamping portion of said tool has a first member having a concavely arcuate surface, and a second member supported for selected clamping movement toward and away from said arcuate surface, and

said forcibly engaging step is performed by placing said arcuate surface externally against a first outer side surface portion of said annular mounting member head portion and placing said second member externally against a second outer side surface portion of said annular mounting member head portion circumferentially spaced apart from said first outer side surface portion, and then forcibly creating a relative clamping movement between said first and second members to laterally deform said annular mounting member end portion to said generally U-shaped configuration thereof.

9. The method of claim **5** wherein:

the resilient mounting member is a resilient compressor mount,

the support portion includes a compressor foot structure in which the circular opening is formed, the circular opening extending between top and bottom sides of he foot structure, and

said axially moving step is performed by moving the deformed mounting member end portion through the opening toward said top side of the foot structure.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,067,700

DATED : May 30, 2000

INVENTOR(S) : Punan Tang, Kenneth R. Swift, Jr. and Ronald J. Rasmussen

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Inventors:, Greenwood, all of "Ak." should be all of --Ar.--.

Signed and Sealed this

Tenth Day of April, 2001

Attest:

NICHOLAS P. GODICI

Attesting Officer

Acting Director of the United States Patent and Trademark Office